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Samsung Information Systems America

INVENTION DISCLOSURE FORM

Department:	Wireless Connectivity (WiCon), New Development Team

Inventors: Sanjeev K. Sharma

Name	Home Address	City	State	Zip
Sanjeev K. Sharma	1440 Stone Pine Terrace # 212	Fremont	CA	94536

Invention Title: Load Balancing Approach for Multi Channel MAC based Access Point

Disclosure of the Invention:

1. Use:
   Are there specific plans for its use?   Yes [√]   No [ ]
   If so, Present _____Yes_____   Future ___Yes_____
   Will it be incorporated into a current product?   Yes [ ]   No [√]
   Date of first shipment or public disclosure

2. Conception of the Invention
   Date of first written description   **07/17/03**

   Where can this be found?   Load_MC_MAC_AP.doc

   Presented or disclosed to others?   Yes [√]   No [ ]
   If so, when?   08/12/03   Disclosed to whom?   Chiu Ngo

3. Construction:
   Was a prototype made?   Yes [ ]   No [√]
   Where can it be found?

   Who worked on it?   Sanjeev K. Sharma (Myself)   Date completed: 08/15/03

   Was it presented or disclosed to others?   Yes [√]   No [ ]
   If so, when?   08/12/03   Disclosed to whom?   Chiu Ngo

4. Was the invention developed for a
   Specific OEM or customer contract?   Yes [ ]   No [√]

   If so, was it disclosed under a
   Non-disclosure agreement?   Yes [ ]   No [√]

   Date it was executed:

Inventor's Signature	Sanjeev K. Sharma	Date: 07/18/03
Inventor's Signature		Date:
Inventor's Signature		Date:

Approved: Read and Understood: Manager's Approval	Name *Chiu Ngo*	Signature	Date 8/25/03
Patent Chairman's Approval	Signature	Date	Process :
Patent Manager's Approval	Signature	Date	Process :

Invention Title:	**Load Balancing Approach for Multi Channel MAC based Access Point**

Disclosure of the Invention – Prior Art

The description should be written in the inventor's own words and follow this guideline:

1. <u>General purpose of the invention. State in general terms what the objectives of the invention:</u>
    The purpose of this invention is efficient utilization of Multi Channel MAC (Medium Access Control) based AP (Access Point) to provide load balancing to the associated clients in order to provide better utilization of the available resources and also to provide the required QoS (Quality of Service) to the associated clients. A new algorithm of making the decisions to offload the overloaded channels is described meeting the required QoS of associated clients.

2. <u>Describe the prior art method/device, its performance, and explain its disadvantages:</u>
    Prior inventions for load-balance schemes in wireless networks employing IEEE 802.11a/b/g, WPAN (Based on IEEE 802.15.3/.3a), Bluetooth and/or other wireless technologies such as GPRS uses an external server, which shall be connected to the wireless access nodes or a wireless switch (for IEEE 802.11a/b/g, GPRS/GSM/CDMA networks) is used in order to provide the load b alancing i f load o n one a ccess n ode increases while, at the same time, resources are available on other access nodes. Network managers need extra hardware equipments (external server to process the decision making of transferring load from one access node to another) and management software.
    Disadvantages:
    - The cost of extra hardware such as wireless switch or a dedicated server, especially in case of IEEE 802.11a/b/g, Bluetooth and WPAN networks
    - Cost of extra management software to be used in order to make the decisions about offloading one access node

3. <u>What is the advantage of your invention over the prior art?</u>
    The advantage of my invention is that network managers do not need an extra server, called a controller or a wired/wireless switch, to make a decision about transferring a connection of a wireless client from one access node to another. Instead, according to my method, same access node employing multiple channels can make a decision locally to transfer one or more clients to another channel based on QoS requirements, RSSI (Received Signal Strength Indication), and/or Load information. If one channel of an access node is overloaded and another channel can support QoS to one of the clients associated with another channel with or without swapping one of its associated clients, our proposed algorithm will help to maintain the load balancing without degrading the performance of the overall network.
    Another important usage of this scheme is that these multiple clients do not need an extra channel for signaling to inform each other about the status of their service, load conditions etc. In this method, an access point/node acts as a local and centralized server making its own decision based on channel loads, QoS requirements (priority), and RSSI values of the wireless clients in order to offload the overloaded channels to the less loaded channel.
    Also, access node/AP can send a disassociate message to the client, whom it thinks can move to another channel to get better services a s a nother c hannel is n ot o verloaded a nd c an a ccommodate the r equirements o f t his c lient in a b etter w ay t han t he current channel, without needing any extra messaging and/or proprietary signals to inform the client to move from one channel to another.
    This invention does not need to have any extra hardware (assuming the access node/AP already has multi channel capability), legacy devices of IEEE 802.11a/b/g will also work without any changes.

Inventor's Signature:	**Sanjeev K. Sharma**	Date:	**07/18/03**
Inventor's Signature:		Date:	
Inventor's Signature:		Date:	

Witness Name:	Paul Fahn		8/22/03
	Please Print Name	Signature:	Date
Witness Name:	Praveen Kumar		9/22/03
	Please Print Name	Signature:	Date

Invention Title:	**Load Balancing Approach for Multi Channel MAC based Access Point**

Disclosure of the Invention - Invention
(Method, Apparatus, or Combinations Thereof)

Completely describe the invention. Include construction, method of operation, materials, and so on. Your description must enable anyone of ordinary skill in the art to make and use the invention. Please attach drawings, photos and other information to this page.

Construction:

The problem is described in **Fig. 1**. We are showing this as an example, using IEEE 802.11a/b/g access node/AP capable of supporting multi channels and clients with or without multi channel capability. The access node/AP employs Multi Channel MAC and has several clients associated on these channels. The traffic has different priorities as shown in **Fig. 1** as an example. AP/access node determines there is imbalance of load on these channels and networks needs to offload one of the channels to support the clients with required QoS. Proposed algorithm will maintain the load balance using this algorithm. Similar problem can be constructed with other wireless technologies such as Bluetooth and wireless personal area network (WPAN).

Method of operation:

Based on the Load information, calculated from the Queue Size, for all the channels, QoS requirements (priority), and received signal strength indication (RSSI) values of associated clients, our intelligent algorithm to be implemented on access node/AP, in case of network topology described in **Fig. 1**, will make a decision which clients shall be moved (offloaded). AP/access node will send disassociate message to the associated client to ask it to disassociate because of the resource constraints.

Algorithm:

This algorithm exploits the information available to the access node/AP without making any changes in the software or hardware part of IEEE 802.11a/b/g based clients. AP/access node can determine the channel load based on the queue size, link strength is indicated by RSSI values received from the radio signals. The traffic passing through this access node/AP is defined with the priority classes as defined in IEEE 802.1D. Based on these three parameters (Queue size, RSSI, QoS priority level), proposed algorithm's flow is described below.

- Based on the load (number of pending packets) on every channel, access node/AP decides weather any of the channels is overloaded or under loaded, a condition for load imbalance.
- After that access node/AP decides on the link which causes this load imbalance and weather that link can be serviced by another channel (based on QoS requirements and availability of resources) with or without swapping another link (in case shifting of this link will cause imbalance). Please refer to flow chart shown in **Fig. 2**.
- Compare the RSSI values before doing the actual transfer of link; to make it sure the new link would be a good quality. The decision is made based on either $RSSI_{new} > RSSI_{old}$ or $RSSI_{new} > RSSI_{Thr}$, where $RSSI_{Thr}$ is the minimum required link strength (this value can be calculated for different type of radios such as IEEE 802.11a/b/g, Bluetooth and WPAN based on Ultra Wideband).
- Make a decision and send a disassociate frame to the client, which shall be transferred, to make it switch to another channel.
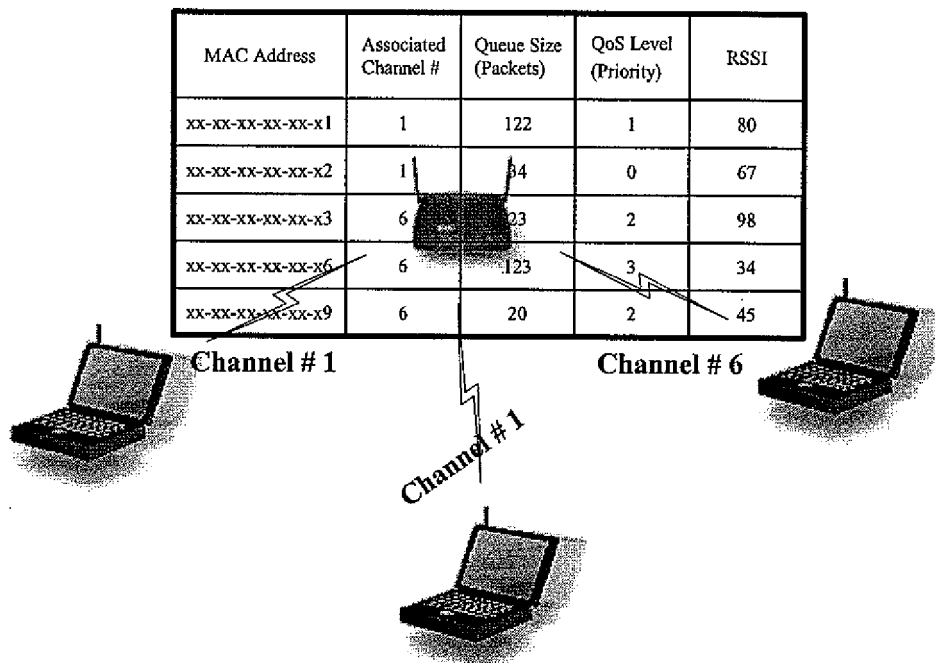
MAC Address	Associated Channel #	Queue Size (Packets)	QoS Level (Priority)	RSSI
xx-xx-xx-xx-xx-x1	1	122	1	80
xx-xx-xx-xx-xx-x2	1	34	0	67
xx-xx-xx-xx-xx-x3	6	23	2	98
xx-xx-xx-xx-xx-x6	6	123	3	34
xx-xx-xx-xx-xx-x9	6	20	2	45

Channel # 1　　　　　　　　**Channel # 6**

Channel # 1

Fig. 1 Construction of the Problem

Any alternative embodiments of your invention? Please disclose:

Inventor's Signature:　　**Sanjeev K. Sharma**　　　　　Date:　**07/18/03**

Inventor's Signature:　　　　　　　　　　　　　Date:

Inventor's Signature:　　　　　　　　　　　　　Date:

Witness Name:　　_Paul Fahn_　　　　　　　_[signature]_　　　_8/22/03_
　　　　　　　　Please Print Name　　　　　　　Signature:　　　Date

Witness Name:　　_Praveen Kumar_　　　　　　_[signature]_　　　_8/22/03_
　　　　　　　　Please Print Name　　　　　　　Signature:　　　Date

Disclosure of the Invention - Invention
(Method, Apparatus, or Combinations Thereof)

Completely describe the invention. Include construction, method of operation, materials, and so on. Your description must enable anyone of ordinary skill in the art to make and use the invention. Please attach drawings, photos and other information to this page.

<u>Further information and drawings:</u>
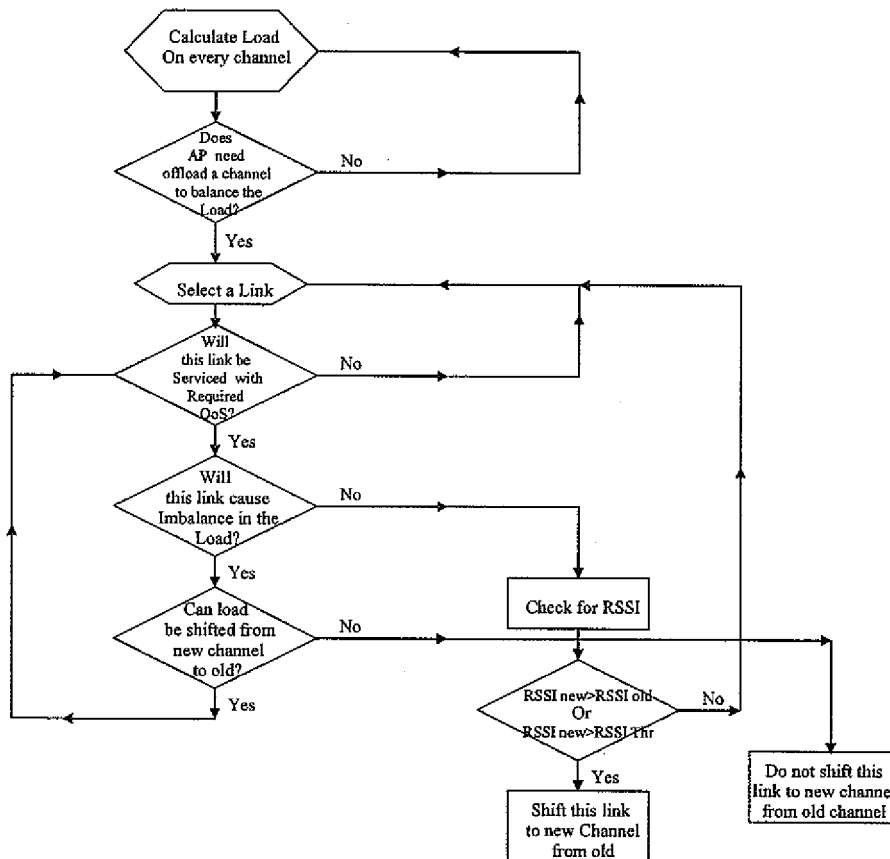
Flow Chart of Proposed Algorithm

Fig. 2 Flow Chart

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Inventor's Signature:		Date:	

Witness Name:	*Paul Fahn*				
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Witness Name:	*Naveen Kumar*				9/22/03
	Please Print Name		Signature:		Date